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Management Summary

This deliverable describes the work carried out in producing the *Integrated Knowledge Model* required at this stage of the S-Cube Network of Excellence. The Integrated knowledge Model is the evolution of the KM with major gaps, overlaps and inconsistencies in knowledge identified, analyzed and landscaped. The work carried out is presented through an analysis of the revisions and changes made to the KM terms. Nine Key Performance Indicators (KPIs) together demonstrate the KM's evolution, the progress made, the results of concentrating effort on the "specialisation" of knowledge and how the public KM has been used by researchers from all over the globe.

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Tilburg University	Netherlands
City University London	U.K.
Consiglio Nazionale delle Ricerche	Italy
Center for Scientific and Technological Research	Italy
The French National Institute for Research in Computer Science and Control	France
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The S-Cube Deliverable Series

Vision and Objectives of S-Cube

The Software Services and Systems Network (S-Cube) will establish a unified, multidisciplinary, vibrant research community which will enable Europe to lead the software-services revolution, helping shape the software-service based Internet which is the backbone of our future interactive society.

By integrating diverse research communities, S-Cube intends to achieve world-wide scientific excellence in a field that is critical for European competitiveness. S-Cube will accomplish its aims by meeting the following objectives:

- Re-aligning, re-shaping and integrating research agendas of key European players from diverse research areas and by synthesizing and integrating diversified knowledge, thereby establishing a long-lasting foundation for steering research and for achieving innovation at the highest level.
- Inaugurating a Europe-wide common program of education and training for researchers and industry thereby creating a common culture that will have a profound impact on the future of the field.
- Establishing a pro-active mobility plan to enable cross-fertilisation and thereby fostering the integration of research communities and the establishment of a common software services research culture.
- Establishing trust relationships with industry via European Technology Platforms (specifically NESSI) to achieve a catalytic effect in shaping European research, strengthening industrial competitiveness and addressing main societal challenges.
- Defining a broader research vision and perspective that will shape the software-service based Internet of the future and will accelerate economic growth and improve the living conditions of European citizens.

S-Cube will produce an integrated research community of international reputation and acclaim that will help define the future shape of the field of software services which is of critical for European competitiveness. S-Cube will provide service engineering methodologies which facilitate the development, deployment and adjustment of sophisticated hybrid service-based systems that cannot be addressed with today's limited software engineering approaches. S-Cube will further introduce an advanced training program for researchers and practitioners. Finally, S-Cube intends to bring strategic added value to European industry by using industry best-practice models and by implementing research results into pilot business cases and prototype systems.

S-Cube materials are available from URL: http://www.s-cube-network.eu/

Contents

Chapter 1

Introduction

1.1 Objective of the KM

The objective of the Convergence Knowledge Model workpackage is defined in the S-Cube Description of Work (DoW) [4] to be:

> *To develop a convergence knowledge model that captures terminology, classifies competences of beneficiaries and their research. The convergence knowledge model will support elimination of duplication of research efforts, better attuning of the research activities of beneficiary institutions and restructuring of already existing research agendas toward a common research objective, integration of knowledge, and, production and harmonization of research results.*

To achieve this objective, the S-Cube Convergence Knowledge Model (KM) will to provide a common understanding of diverse knowledge in the form of a Web-based, free, open-content living encyclopedia of service-specific knowledge. The S-Cube KM will offer a dynamic, interactive application to define associations between concepts, approaches, methodologies and competencies (i.e., abilities and scope of knowledge) of each partner. The KM will help users to negotiate this large body of knowledge by providing them with mental cues for navigating across different knowledge domains related to all aspects of service-oriented research, associated methodologies and supporting environments.

Representation of Knowledge

S-Cube's Knowledge Model forms part of the S-Cube integration framework as it maps, integrate and synthesize the diverse concepts and knowledge of partners from different research areas in the network. It does this by positioning the information within the intersections of the three service technology and three service engineering and adaptation methodologies:

- Service Technologies:
  - Business Process Management (BPM)
  - Service Composition (SC)
  - Service Infrastructure (SI)
- Technology Principles, Techniques & Methodologies:
  - Engineering and Design (ED)
  - Adaptation and Monitoring (AM)
  - Quality Definition, Negotiation and Assurance (QA)

These six cross-cutting research activities of S-Cube are represented in the joint research activities (JRAs) of the S-Cube partners and in the structure of knowledge captured in the KM; each *term* has a matrix structure that allows the cross-correlation of knowledge between research activities (as required by the KM vision) through the placing of knowledge a *definition* or *definitions* in the appropriate cell. The structure of a KM term, or service-specific concept, is shown in Table 1.1.

Term Name		Technology Principles, Techniques & Methodologies			
		Engineering & Design (ED)	Adaptation & Monitoring (ED)	Quality Definition Negotiation & Assurance (QA)	Generic or Domain Independent
Service Technologies	Business Process Management (BPM)				
	Service Composition & Coordination (SC)				
	Service Infrastructure (SI)				
	Generic or Domain Independent				

Table 1.1: The S-Cube KM Template / Knowledge Matrix

The structure in Table 1.1 acknowledges that each research discipline and area can use a different definition of terms; i.e., depending on the context in which the term is used, its definition or meaning can differ. If a definition is generic across more than one domain or layer, the definition will be placed in the respective "generic" cell. As we will describe, part of the work of this S-Cube activity is to align, integrate, refine and specialize these different definitions. Thus, the matrix structure for the S-Cube KM definition allows cross-correlating and aligning definitions where needed, while still maintaining the traceability to the fundamental definitions of the respective research fields.

1.2 Focus of Recent Work

Following M12 of the project (March 2009) the main effort of this activity has been and continues to be directed into making the definitions contained in the KM more integrated, accurate, refined and specific. As this document will describe, this has involved the production of tools to determine which terms require specialization, the modification, linking, movement and/or specialization (i.e., by editing a generic definition to a more specific definition) of definitions and the development of a Quality Assurance (QA) process to ensure the changes carried out add value to the KM. These activities has been preferred to adding more terms to the KM (although a small number of new terms have been added) in order to ensure the information in the KM remains of a high-quality.

1.3 Positioning of this Deliverable

The previous deliverable of this workpackage CD-IA-1.1.2 [2] described the vision for the KM and how the template for recording knowledge had been developed, the number of terms and definitions present in the KM and the distribution of knowledge between domains at that time. The previous deliverable also proposed a series of short, medium and long-term activities this integration activity should follow as part of task T-IA-1.1.2 “Initial Definition and Incremental Evolution of the Convergence Knowledge Model”. This deliverable reports on the progress of the short and medium term activities by deriving their Key Performance Indicators (KPIs) and the values for the mandatory KPIs required at this milestone of the WP-IA-1.1 activity. Progress on long-term activities will be reported in the the next deliverable of this workpackage (PO-IA-1.1.4).

Within the Integration Framework of S-Cube (IA-3), the KM forms one of the foundations for that work by providing a common, agreed vocabulary through which a validated, coherent and holistic framework for service-based systems engineering, adaptation and monitoring can be defined. For example, terms from the KM have been used when describing research challenges, questions and results in the IA-3.1 “Integration Framework: Baseline & Definition” and IA-3.2 “Integration Framework: Validation & Personalisation” activities. In future work, further integration of the KM with the Integration Framework is planned through the identification of appropriate scenarios for relevant terms and their definitions, linking them together. With respect to the activities of IA-3, this deliverable describes the work and the metrics used to measure the progress in producing and maintaining the *Integrated Knowledge Model* the Integration Framework — and other activities of S-Cube — are now using.

The remainder of this deliverable is structured as follows: Chapter 2 presents the metrics we used to measure progression of the KM; Chapter 3 describes the values of the metrics and how they were calculated; Chapter 4 provides analysis of the metrics, a conclusion and a description of future work for S-Cube’s Convergence Knowledge Model.

Chapter 2

Measuring Integration

This chapter describes the nine metrics used to measure the development and integration of knowledge in the KM and the rationale for choosing those KPIs.

2.1 M21 Key Performance Indicators

From the DoW, the progress of the integration of the KM at milestone M3-IA-1.1 is to be measured using the KPIs shown in Table 2.1. The KPIs for the knowledge model are designed to measure the coverage of the knowledge model, the use of the model as a means of integration and its effectiveness with respect to achieving the overall integration aim of S-Cube [4, Sec. B.1.3.1.10]. The KPIs required by the DoW are mainly concerned with the integration of accumulated knowledge contained in each functional layer into one coherent model and developing the Integrated Knowledge Model required at this stage of the network.

Sub-Milestone Number	SubMilestone Name	Key Performance Indicators
M3-IA-1.1	Integrated Knowledge Model	Number of users of the Knowledge Model. Number of collaborations established within the network. Number of co-authored publications.

Table 2.1: DoW KPIs for the M21 Sub-Milestone

Each of the KPIs shown in Table 2.1 is now described. Their values and analysis of the results are given in Chapter 3.

KPI 1: Number of KM Users

The number of users of the S-Cube Convergence KM is measured through two values: the number of S-Cube researchers who can add and edit knowledge in the KM and the number times the KM had been used. To establish the first value we used administration functions within the S-Cube portal. The second value was found through Google Analytics, “a free service offered by Google that generates detailed statistics about the visitors to a website” [1], which has been monitoring the S-Cube portal since its deployment. From this data we can calculate the number of *Sessions*, or the times a visitor has interacted with the knowledge model using their browser. A session ends when the browser is closed or shut down, or when the user has been inactive on that site for a specified period of time. A session is considered to have ended if the user has been inactive on the KM for 30 minutes[1]. Using the Session data Google Analytics provides, we found the number of times the KM had been accessed via the S-Cube portal and where those sessions came from since the KM was made available to the public in M13 (March 2008) of the S-Cube network (described further in Section 2.2.1, below).

KPI 2: Number of Collaborations Established in the Network

Together with the other integration activities, such as WP-IA-2.1 "Mobility of Researchers", the KM provides a mechanism for S-Cube researchers to collaborate through the identification of common and complementary research interests and competencies. However, measuring the number of research collaborations established in the network is not directly measurable through the KM, therefore in order to determine this figure we took information from two sources: the number of mobility stays from S-Cube deliverable CD-IA-2.1.3 [5] and the number of planned joint publications from deliverable CD-SoE-1.2.5 [3]. Together these will help to show the level of research integration and alignment of partners.

KPI 3: Number of co-authored Publications

Similar to the previous KPI, the number of co-authored publications is one of the mechanisms through which research integration is demonstrated in the S-Cube network. This figure is related to the KM since the KM provides a mechanism for S-Cube researchers to collaborate through the identification of common and complementary research interests and competencies. A record of co-authored or joint publications is maintained as part of the management and reporting activities (specifically, by WP-Mgt-1.2 "Scientific & Technical Management"). Partners use a central *bibadmin* tool to archive their articles and papers and from the analysis of this database we can determine the number of co-authored publications.

2.2 Additional KPIs

Although the KPIs presented above give some indication of the progress of the S-Cube KM, additional KPIs can be given to demonstrate the work carried out as part of task T-IA-1.1.2, including "Incremental Evolution of the Convergence Knowledge Model", in particular to show how major gaps, overlaps and inconsistencies in KM terms have been identified, landscaped and analyzed as required by the deliverable description in the DoW. From CD-IA-1.1.2's recommendations for short, medium and long-term activities (introduced in Section 1.3) we have chosen the following KPIs to demonstrate this progress[2]:

2.2.1 Short-Term Activities of CD-IA-1.1.2

KPI 4: Number of New Definitions

As described in Section 1.2, the majority of our work in the last period has been to concentrate on increasing the accuracy of the knowledge contained in the KM through the addition, refinement and landscaping of definitions contained in the KM terms. Part of this effort has been to introduce new definitions for each term to populate the knowledge matrix shown earlier in Table 1.1. We have preferred to concentrate on improving and adding to the definitions contained in the terms over the addition of new terms as we feel the current set of terms is comprehensive (though not complete) and well-balanced. Focusing on the definitions helps us achieve the goal of this period of work, which is to find "major

[1] `http://google.com/support/analytics/bin/answer.py?hl=en&answer=33073`

[2] The progress of the long-term activities will be reported in the next deliverable from this workpackage, PO-IA-1.1.4 "Report on alignment of short-term research agendas of beneficiaries".

gaps, overlaps and inconsistencies" in the knowledge and then to "identify, landscape and analyze" that knowledge to provide an Integrated Knowledge Model.

This KPI will measure the number of new definitions added to terms as a result of the efforts of T-IA-1.1.2. The number of new definitions since CD-IA-1.1.2 (M12 of the S-Cube network) can be found through an analysis of the distribution of definitions in the 16 cells of the knowledge matrix and comparing the distribution from M12 to those in M22. In order to do this we developed set of tools as part of this work that can find this information through the running of automated scripts. These tools can provide much more information about the activity in the KM and are used to find several of the KPIs described in this report. The tools are described in Appendix A.

KPI 5: Increase in 'Specialized' Knowledge

As described above, the main objective of this period of work has been to find the "major gaps, overlaps and inconsistencies" in the Knowledge Model. After carrying out a review of the information contained in the KM after M12 of the network, we found that many terms are defined generally though the use of the generic cells in the knowledge matrix, possibly reflecting the state of partners knowledge at that stage in the network. However, as partners' knowledge and experience in the area of software systems and services has increased in the time since those initial definitions were given, we feel that further, more accurate and specialized definitions can be added to reflect the partners increased understanding of software systems and services. Thus, the specialization of knowledge — which we define as the increase in definitions in the cross-cutting cells of the knowledge matrix between service technologies and service principles, techniques and methodologies — will increase the accuracy and relevance of the S-Cube KM.

Measuring the number of specialized terms requires knowledge of the distribution of definitions within the KM (i.e., within the knowledge matrix shown in Table 1.1) for all terms in the knowledge model to determine where effort should be concentrated and specialization should take place. In order to discover this information, we used the tools introduced in Appendix A to find all terms which had a generic definition. Partners were then assigned these terms as part of the QA process (described in Section 3.2) and asked to review them over a period of two months to identify new references to internal and external documents, articles and papers, where specialist definitions were missing and which definitions could be modified for accuracy or moved to another cell.

The end-result of this process is the "landscaping" of the KM, or smoothing of the distribution of the knowledge contained in the terms, to include more specialist information in order to produce the Integrated Knowledge Model, as required by the task description. The integrated KM will help the S-Cube project identify where areas of research and knowledge are incomplete, missing or duplicated. The goal of this undertaking is to allow the streamlining and consolidation of the research agendas of the partners in the network as a first step and to the European Software-Services community in the future through the S-Cube integration framework.

KPI 6: Updated & Corrected Competencies

At the end of the first year of the S-Cube project, some of the competency information was missing or incorrectly formatted. As a result, a recommendation of CD-IA-1.1.2 was to update and correct competency lists for each term, listing people and organizations from the S-Cube consortium. The process of updating and correcting competency information was included in the QA process developed for the S-Cube KM, which is introduced below.

KPI 7: Providing Public Access

Short-term activity 2.8.1.3 in CD-IA-1.1.2 was to provide public, read-only access for non-network users to the KM through the S-Cube Web Portal. This KPI describes when this was achieved.

2.2.2 Medium-term Activities of CD-IA-1.1.2

KPI 8: Development of a QA Process

A medium-term activity for the KM was to develop a quality assurance process for the KM. This section describes the motivation for developing the QA process with the QA process and its results presented in Section 3.2.

A QA process for the KM is necessary since "the KM will be open in nature, allowing for contributions from all the partners in the network and, later, the wider research community. To ensure the quality, homogeneity, and consistency amongst terms, the KM should adopt a well-defined governance structure, including a quality assurance process. The quality assurance process will prescribe a procedure to review additions, changes or removal of KM entries, define or modify user access rights, release parts of the knowledge model to the broader research community and consolidate terminology" [2, Sec. 2.6].

With the concentration on increasing the quality and accuracy of the definitions contained in the KM, we developed the QA process as a means of checking and validating the new and modified knowledge added or changed during this effort. The QA process has the goal of identifying major gaps, overlaps and inconsistencies in the information, connecting related terms together with hyperlinks and to validate of the format of partner competency information, which at the end of M12 was not always consistent. The correct formatting of partner competencies, terms and their contents in the KM is essential in order for the automated tools we have developed to operate correctly and to give the correct data about knowledge contained in the KM. The tools assisted in identifying incorrectly formatted information in the KM (particularly the competency information) by reporting the location of problems it found during the analysis of each term. The QA process and its results are fully described in Section 3.2, below.

KPI 9: Number of Terms 'Quality Assured'

Following on from the previous KPI, the development of a QA process allows us to check and validate terms, definitions and competency information. This KPI measures how many of the KM terms have been quality assured using the QA process and how many of the definitions were actually modified as a result of the process.

Chapter 3

Results

This section presents the progress made on the S-Cube KM from that reported at M12 in deliverable CD-IA-1.1.2 through the nine KPIs described in the previous section.

3.1 Analysis of KM Terms

3.1.1 Revision Data

From the KM analysis tools, we established there were a total of *2,805* revisions to all terms from M12 to M21 of the S-Cube project. The distribution of these revisions by project month is shown in Figure 3.1.

Using the same data we can also show the frequency of updates to KM terms by determining their 'last modified dates', or the dates and times at which terms were last updated or changed. The location of this information in the KM term is shown in Figure 3.2, and Figure 3.3 shows the distribution of terms by their last modification date.

3.1.2 Current KM

As a result of the "landscaping" of definitions shown above, the distribution of definitions has been smoothed and within the nine specialized cross-cutting concern cells the average number of definitions for all terms is 15.5 (standard deviation, $\sigma = 3.4$). Table 3.2 illustrates this development by showing the distribution of definitions for all terms within the KM term knowledge matrix. To show how the distribution has changed as a result of our efforts, in each cell two values are given; the first is the M12 value and the second is the current value at the time of writing this report. Data for the previous period are taken from [2, Fig. 10].

	Sep. 2008	Mar. 2009	Dec. 2009
Terms	72	275	282
Definitions (all)	79	321	464
Generic Definitions	N/A	292	324

Table 3.1: Evolution of the Convergence KM Since Inception

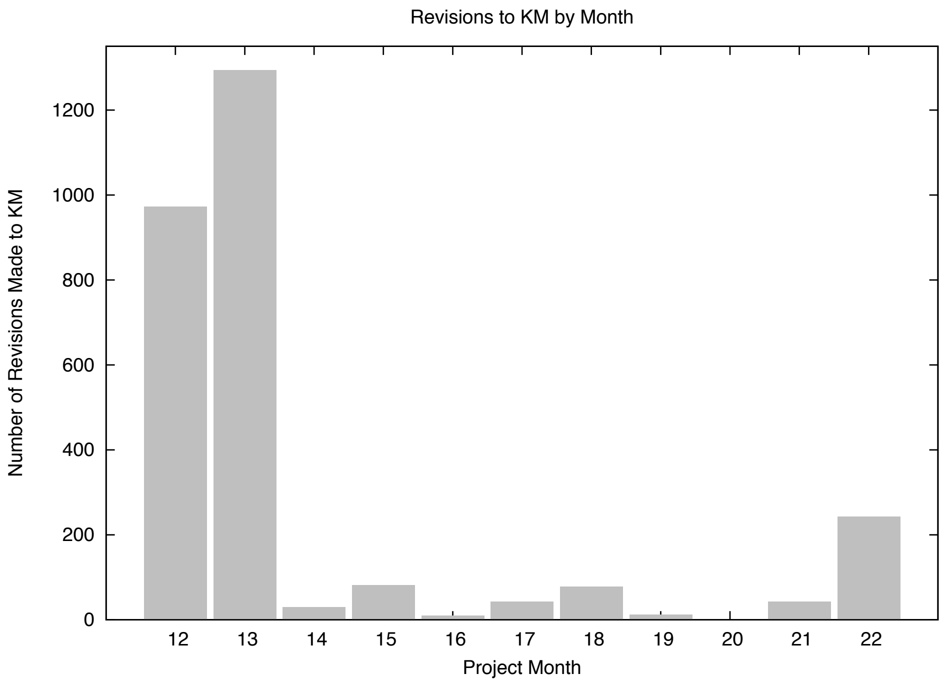

Figure 3.1: Number of Revisions to KM Terms by Project Month

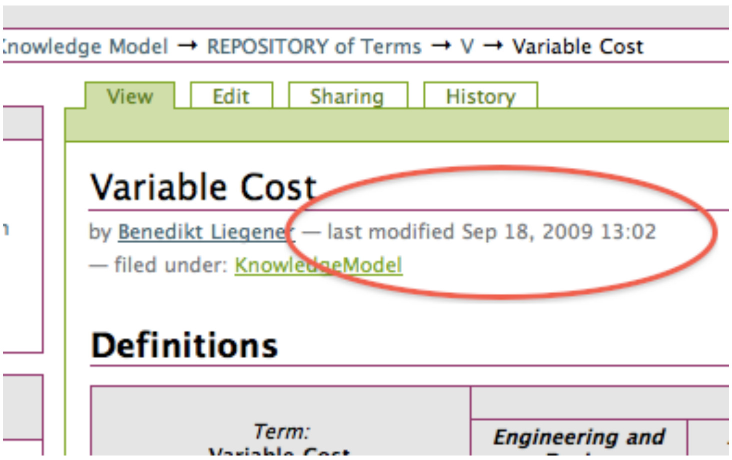

Figure 3.2: Example KM Term Highlighting the Location of the Last Modified Date

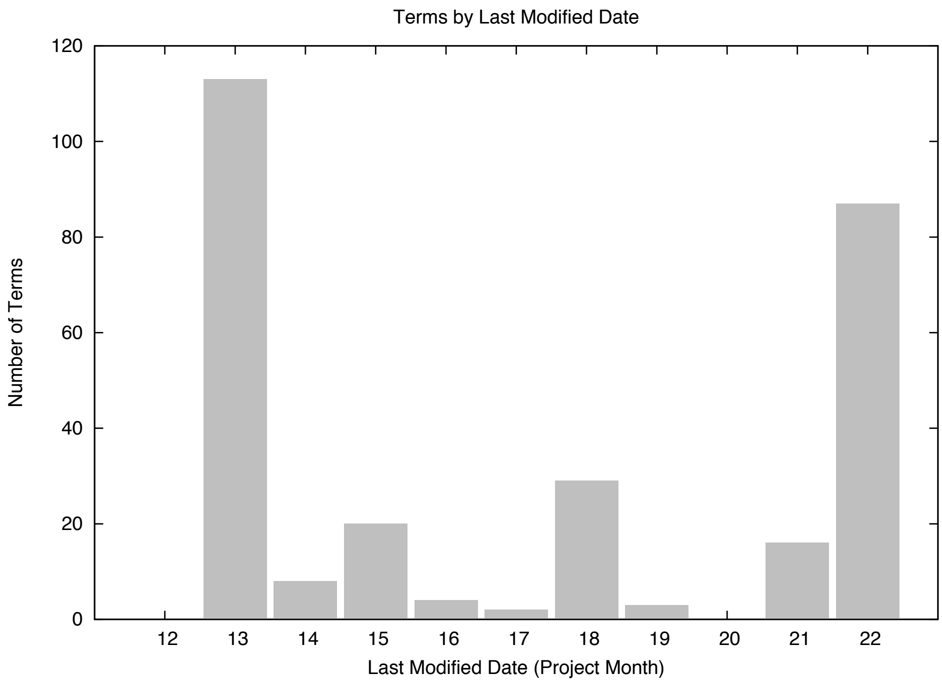

Figure 3.3: Number of Terms by Last Modified Month

3.2 KPI Measurements

This section contains the measured values for the nine KPIs introduced in Chapter 2. All data about the KM was taken on 11^{th} December 2009.

KPI1: Number of KM Users

As described in Section 2.1, this KPI is found through two values; the number of S-Cube researchers who can add and edit knowledge in the KM and the number times the KM was accessed via the S-Cube portal. From the S-Cube KM Platform's administration functions, we have established there are *110* registered users (i.e., with the ability to add and edit knowledge) of the S-Cube Knowledge Model.

The number of times the read-only KM was used is found through Google's Analytics service, which provides us with the number of unique pageviews for each URL the S-Cube web portal has. A unique pageview is the aggregation of pageviews by the same user during the same session and the number of unique pageviews represents the number of sessions during which a term was viewed one or more times. Since the time between pageviews is critical to the definition of a session, a single pageview event does not constitute a session (it is a "bounce"). Therefore, we are confident using the session data will give us a good indication of how many times the KM has been used since deployment.

With Google Analytics we found the total number (i.e., sum) of unique pageviews of all the KM terms to be *2,374*, with the top 10 terms by unique pageview shown in Table 3.3.

Using the location data Google Analytics also provides, we found the number of countries using the KM was *92*. The top 10 countries using the KM are shown in Table 3.4. What is interesting about this top 10 is that two of the countries listed (United States and India) do not have participants in S-Cube and we feel their use of the KM indicates the usefulness of the S-Cube KM to external researchers. The full

All Terms		Technology Principles, Techniques & Methodologies			
		Engineering & Design (ED)	Adaptation & Monitoring (ED)	Quality Definition Negotiation & Assurance (QA)	Generic or Domain Independent
Service Technologies	Business Process Management (BPM)	$2 \rightarrow 17$	$2 \rightarrow 14$	$1 \rightarrow 18$	$25 \rightarrow 31$
	Service Composition & Coordination (SC)	$1 \rightarrow 18$	$5 \rightarrow 21$	$1 \rightarrow 14$	$37 \rightarrow 31$
	Service Infrastructure (SI)	$6 \rightarrow 9$	$10 \rightarrow 17$	$1 \rightarrow 12$	$0 \rightarrow 18$
	Generic or Domain Independent	$68 \rightarrow 78$	$43 \rightarrow 43$	$80 \rightarrow 87$	$39 \rightarrow 36$

Table 3.2: Results of "Landscaping" KM Definitions into More Specific Knowledge

list of countries accessing the KM ranked by pageview is shown in Table B of Appendix B.

KPI 2: Number of Collaborations Established in the Network

As described in Chapter 2, the number of collaborations established in the network is demonstrated through two figures: the number of researcher mobility visits made and the number of planned joint publications between partners. Table 3.5 shows this data, which was obtained from CD-IA-2.1.3 [5] and CD-SoE-1.2.5 [3].

KPI 3: Number of co-authored Publications

From the S-Cube *bibadmin* database we have determined that there were *34* co-authored publications in the period March 2008 to December 2009. These co-authored publications represent *37%* of S-Cube's publication output.

KPI 4: Number of New Definitions

From the information shown in Table 3.1, we can determine that there were *143* new definitions added to the KM, a increase of *44.5%*.

KPI 5: Increase in 'Specialized' Knowledge

The increase in specialized knowledge can be found through looking at the differences in the past and current distribution of KM definitions between all terms. As shown in Table 3.2, the number of terms in the nine specialized cross-cutting concern cells has increased from an average number of definitions per term of 3.2 (σ = 2.9) at M12 to 15.5 (σ = 3.4) at M21. We can compare this increase in specialized

Rank	Term Name	Unique Pageviews
1	Software Process Model	123
2	Quality-of-Service Dimension	95
3	Quality-of-Service Characteristic	82
4	Ideal Model	47
5	Service-Oriented Software Engineering	43
6	Key Process Area	35
	Business Transaction	35
8	Self-Healing System	34
9	Grid Scheduling	29
10	Data Validity	28

Table 3.3: Top 10 KM Terms by Unique Pageview

Rank	Country	Unique Pageviews
1	Italy	155
2	Germany	131
	Ireland	131
4	Netherlands	104
5	**United States**	98
6	France	71
7	United Kingdom	62
8	Austria	60
9	**India**	51
10	Hungary	50

Table 3.4: Top 10 Countries Accessing KM Terms by Unique Pageview

KPI	Value
Number of Researcher Mobility Visits Made (at M18)	24
Number of Planned Joint Publications (at M20)	46

Table 3.5: KPIs for Number of Collaborations Established in the Network

	Mar. 2009	Dec. 2009
Avg. Number of Definitions / Specialist Cell	3.2	15.5
Avg. Number of Definitions / Generic Cell	41.7	46.2

Table 3.6: Relative Increase in Specialized Knowledge

knowledge to the small relative increase of generic knowledge (i.e., any definitions in the seven generic cells) of 41.7 (σ = 29.4) at M12 to 46.2 (σ = 24.0). What these figures show is a) the amount of specialist knowledge in the KM has increased relative to the generic knowledge and b) the low standard deviation of the distribution of specialist knowledge at M21 indicates the number of definitions in the specialist cells tends to be close to the average, i.e., the knowledge has been "smoothed".

KPI 6: Updated & Corrected Competencies

At the end of M12 of the S-Cube network, we found that *43* KM terms had problems with the format or content of partner competency information. These problems ranged from incorrect hyperlinks for institutions to competencies with no people assigned. During the QA process this competency information was corrected. To ensure that no further format or content errors creep in as competencies are updated, the KM analysis tools were also developed to check the format and structure of the competency information, including hyperlinks and misspellings of people's names. As a result, we can now automate the checking of competency information and this is carried out on a routine basis to ensure the information continues to be in a standard format.

KPI 7: Providing Public Access

Public access to the S-Cube KM was provided in 23^{rd} March 2009 (M13 of the S-Cube network).

KPI 8: Development of a QA Process

Previously, we have developed a Quality Control process for the initial population of the KM and this had worked well in ensuring that information and data were entered in a consistent manner. This process is described in CD-IA-1.1.2 [2]. The new QA process was developed as a means of checking the new and modified term definitions and partner competency information was of the quality expected for the KM — i.e., this process was not to check information was in the correct tabular format, but to check the contents of the definitions for accuracy, relevancy and focus to ensure the information the KM contains is of a high-standard.

The QA process was developed as a result of our experiences as a result of an increase in the volume of knowledge when in separating the knowledge models for functional layers in M6-12 of the S-cube network: initially, we had assigned a task for the manual checking the competency information, but this was costly in terms of time and the development of an automated tool allowed competencies to be checked more easily for compliance with the entry template. Thus some tasks contained in the early QA process, such as harvesting revision data and checking term definition, format and competency information, are now centralized and performed routinely.

Currently, in addition to running the automated tools, the manual tasks of the QA process are, for each term, to validate the following:

1. Definition entries should be in correct english and edited to concise descriptions rather than out-of-context sentences.

2. Links between definitions and their more general definitions, specialist definitions, synonyms and related terms are encouraged. For example, the definitions in *Process* are also linked to (the more specialist) *Process Model* and *Process Instance* terms, who in turn link back to *Process*. Related terms (like *Fault* and *Failure*) can also be linked with a description of their relationship.

3. Definitions found in the generic service technology or generic service principles, techniques and methodologies cells must be checked for applicability and soundness. If the definition can be made more specific or a more specific definition can be added, the definition text should be moved or added to the correct specialist cell.

4. References to deliverables and/or research papers should be added to all definitions where possible. The editor of each deliverable should be contacted for clarifications and help on terminology found in S-Cube deliverables.

5. New terms can be added, for example where when a piece of knowledge is defined in an S-Cube document but not in the KM, but this is of low priority.

Items 1 and 2 of the QA process were applied over all terms following M12 of the project; this is why Figure 3.1 shows a large spike in the number of revisions carried out in M13 (M12 are the revisions from the initial population of the KM) and Figure 3.3 shows how all terms have been updated at least once since M12 due to the QA process. To ensure consistency of the definition formatting, this task was carried out by one partner (UniDue).

Items 3 and 4 were mainly applied to terms which had at least one definition in one of the generic cells of the knowledge matrix. Note that these items were *mainly* applied to the terms having generic definitions but can be applied to any term as the editor wishes as it becomes necessary to add further definitions to other terms (e.g., when linking between terms).

Carrying out items 3 and 4 required us to distribute the terms between partners to share the effort. After M12 of the network, the number of terms containing a generic definition stood at 268 (nearly all the terms at that point in time) with 64 terms belonging to the JRA-1 activity and 204 terms belonging to the JRA-2 activity. These terms were split between partners for QA randomly, with the only constraint on allocation being that partners who are mainly involved with JRA-1 activities should check the *204* JRA-2 terms, whilst partners who are mainly involved with JRA-2 should check the *64* JRA-1 terms. This constraint was applied in order to help ensure that an S-Cube member who originally defined a term had less chance of reviewing the term during the QA process.

As can be seen in Table 3.2, the effect of the QA process has been to close the gaps (in terms of number of definitions contained in the KM) between domains and to harmonize the distribution of terms. The result of this process can be found in the KPI below, and the detailed records of changes made to KM terms by partners as a result of the QA process are given in shortened form in Appendix C.

KPI 9: Number of Terms 'Quality Assured'

From the results found from the automated KM tools, we have found that all of the original *275* terms have been subjected to items 1 and 2 of the QA process since all terms have a last modified date greater than or equal to the date items 1 and 2 of the QA process were completed. Of these *275* terms *268* of them were checked again as part of carrying out items 3 and 4 of the QA process. We are therefore confident that the vast majority of the terms in the KM are of a high quality, not only in their formatting and presentation but also in the content and knowledge they contain.

We can cross-correlate the last modified and revision data with the reports of work carried out on the KM from S-Cube partners during the QA process (the results of which are given in Appendix C) to break down the changes made in the QA process into more detailed information. Table 3.7 shows the details of the changes made. The emphasis on adding and specializing definitions to existing terms can clearly be seen.

3.3 Summary of Results

The objective of this period of work for this workpackage has been to produce the Integrated Knowledge Model, with major gaps, overlaps and inconsistencies in knowledge identified, analyzed and landscaped. Table 3.2 shows how the changes made by this activity (in Table 3.7) has resulted in the "smoothing"of the distribution of definitions within terms through an increase in the number of specialized definitions within the KM terms. The development of a QA process has ensured this new knowledge is of a consistent and high-quality.

	Total
New Terms	7
Definitions added	143
Definitions modified	50
Definitions moved	8
Definitions removed	2
References added	46
Competencies added	17
Terms corrected for format	8

Table 3.7: Details for Revisions carried out as part of QA Process

Making the KM public in March 2009 has resulted in over 2000 uses of the KM, including from countries as far afield as Nepal and Fiji. Altogether, the results of the nine KPIs described above demonstrate the effort we have put into making S-Cube's convergence KM an important information source for the service science community.

Chapter 4

Conclusion

The objective of the period M12-M21 of this workpackage has been to perform the integration and specialization of knowledge the terms in the KM, with major gaps, overlaps and inconsistencies in knowledge identified, analyzed and landscaped. The work we have carried out and described in this deliverable has attempted to meet this challenge. The results from the analysis of work carried out, the number and types of revisions made and the portal's analytics have, we feel, demonstrated that the KM has evolved into the Integrated Knowledge Model required at this stage in the network.

4.0.1 Future Work

Future work in this workpackage will follow the description of work to pursue the overall vision for the KM. As a result of the progress made in the last six months of work to produce the Integrated Knowledge Model, some of important pieces of outstanding work are:

- **More Analytics.** Using Google Analytics to find the total number of uses of the KM together with the geographic location of people accessing the KM has provided us with some interesting data. For instance, we found two of the top 10 countries accessing the KM are the United States of America and India and the KM has reached countries such as the Philippines and Kenya (18^{th} and 19^{th} in the ranking list). In the coming period, we would like to use analytics more to find out why users are coming to the KM. For instance, are they coming from Google via a search, or being referred by other websites? Finding this information will be critical in carrying out KM Promotion.

- **KM Promotion.** Together with the spread of excellence activity, we will use the analytics information to make targeted promotions to give effective publicity to the S-Cube KM so it is used more outside the network and its use in academia and industry is encouraged.

- **KM Visualization:** An interesting challenge going forward will be the presentation of the aggregated knowledge contained in the KM. At the moment, knowledge is contained in each term (each on a separate webpage) and, whilst this is satisfactory for viewing the detailed information about each term, it doesn't give a high-level picture of how the knowledge is structured or what the most important terms are. A piece of currently ongoing work for this workpackage that shows such information.

- **Sustainability.** An ongoing task is to investigate the sustainability options for the KM after the end of the S-Cube network. The KM represents an important knowledge resource that may be used in a number of different fields and for different purposes, ranging from reference material for educational purposes to a direct application in service description. Maintaining the KM in the post-project period is therefore of great interest to the network.

Appendix A

KM Analysis Tools

A.1 Tool Description

The KM analysis tools were developed to automate many of the functions necessary with tracking the progress and development of the Integrated Knowledge Model. For instance, checking the distribution of definition within all *282* terms by hand would have been a tedious and time-consuming process and an early recognition of this encouraged us to produce a set of simple tools to provide and analyze the data required for this report. This section describes at a high-level the operation of the tools.

Note that these tools, which access the KM via a remote HTTP connection, do not effect the data gathered by the Google Analytics service; i.e., the traffic and interaction data from Google do not include visits, sessions or page fetches made by these tools. This is because of how Google Analytics is implemented; it uses a page tagging technique to collect visitor information via a combination of JavaScript and cookies. However, the HTTP client we use (from Ruby's standard library) does not make use of either of these technologies and can operate undetected by Google Analytics. This is shown by the analytics data collected: terms have been analyzed several times using the tools by researchers at Tilburg University, the Netherlands, but these interactions are not present in the page view data, many of which show only pageviews from other countries.

A.1.1 Definition Finder

To find the definitions contained within terms we developed a tool to automatically analyze each term. This tool starts from the KM term index page[1], which contains a list of all terms, and follows the hyperlinks to each term. The benefit of using a standard representation for each term (i.e., the knowledge matrix shown in Table 1.1) is that we can determine if a definition exists within any of the cells easily and count the number of definitions (each wrapped in special metadata) within each cell. Carrying this out over all the terms found on the index page provides us with a profile of the distribution of definitions within each intersection of service technologies and service principles, techniques and methodologies.

The graph of terms and their interconnections found using this tool can then be used to visualize the KM, an ongoing task in this workpackage that will allow the viewing of the knowledge in the KM in what we hope is a novel and unique manner.

A.1.2 Competency Checker

A short-term task from the previous deliverable of this workpackage, CD-IA-1.1.2 [2], was to update and corrected competency information contained in the terms. To pinpoint errors, we implemented a script that can check the formatting of information contained in each entry, the correct institution name

[1] `http://s-cube-network.eu/km/all-entries`

and location of the accompanying URL (against a set of key-value pairs of institution name and standard URL) and that each researcher's name found is contained in a set of S-Cube researcher names.

The script can give a detailed output of exactly where each error is taking place with links to each page to facilitate quicker editing of errors. Using this method we correct all competency formatting errors found previously and can ensure any future mistakes will be found and rectified quickly.

A.1.3 Revision Counter

The platform the KM is implemented on, Plone[2], stores previous revisions of pages in case a previous version of a page is preferred to the current page, like similar functions in Wikipedia or other content management systems. Using this function we can find the number of revisions made to all terms contained within the KM, when they were made and when a term was last updated. We developed another script to access this data and make a record of the revision history for each term (using a simple array of dates) and then analyzed these revision histories to find various statistics, like the total number of revisions made and the distribution of revisions, etc.

[2] `http://plone.org`

Appendix B

Countries Accessing the KM

The following is a list of countries from which the kM has been accessed ranked by unique pageviews.

Rank	Country	Unique Pageviews
1	Italy	155
2	Germany	131
	Ireland	131
4	Netherlands	104
5	United States	98
6	France	71
7	United Kingdom	62
8	Austria	60
9	India	51
10	Hungary	50
11	Spain	47
12	Greece	40
13	Sweden	30
14	Canada	29
15	Australia	20
16	Pakistan	15
	China	15
18	Philippines	13
19	Kenya	10
	Singapore	10
21	Belgium	9
22	Vietnam	8
	Malaysia	8
	South Africa	8
25	Turkey	7
	Brazil	7
	Indonesia	7
	Colombia	7
29	Finland	6
	Portugal	6
	Mexico	6
	Bulgaria	6
	Romania	6
34	South Korea	5
	Hong Kong	5
	United Arab Emirates	5
	Japan	5
	Iran	5
39	Russia	4
	Egypt	4
	Jamaica	4
	Norway	4
	Switzerland	4
	Czech Republic	4
	Nigeria	4
46	Saudi Arabia	3
46	Lithuania	3
	Denmark	3
	Sri Lanka	3
	Poland	3
	Palestinian Territories	3
	Thailand	3
	Jordan	3
	Taiwan	3
	New Zealand	3
56	Nepal	2
	Israel	2
	Morocco	2
	Bangladesh	2
	Sudan	2
	Uganda	2
	Iceland	2
	Cyprus	2
	Argentina	2
	Albania	2
	Ghana	2
	Slovenia	2
	Serbia	2
	Ethiopia	2
70	Fiji	1
	Slovakia	1
	Luxembourg	1
	Saint Lucia	1
	Qatar	1
	Puerto Rico	1
	Cuba	1
	Costa Rica	1
	Peru	1
	Swaziland	1
	Chile	1
	Mauritius	1
	Cameroon	1
	Tanzania	1
	Malta	1
	Tunisia	1
	Kuwait	1
	Bahrain	1
	Latvia	1
	Uruguay	1
	Lebanon	1
	Algeria	1
(92)	Libya	1

Table B.1: List of Countries Accessing the KM Ranked by Unique Pageviews

Appendix C

Results of QA Process

The following is the log of the results of the QA Process for the terms quality assured.

Partner	Term	Result of QA Process
UniDue	Accountability	No modifications made
	Actor	No modifications made
	Adaptation	No modifications made
	Availability	No modifications made
	Change Cycle	No modifications made
	Confidentiality	No modifications made
	Culture	Corrected term format
	Data-Related Quality	No modifications made
	Declarative Quality of Service Models	No modifications made
	Dependability	No modifications made
	Design for Adaptation	No modifications made
	Design Principle	Corrected term format
		Corrected SC-ED definition
	Elicitation	No modifications made
	Error	No modifications made
	Hard Goal	No modifications made
	Human Computer Interaction	No modifications made
	Life Cycle Model	Corrected ED-Generic definition
	Manual Service Deployment	Corrected ED-Generic definition
	Mediation	No modifications made
	Monitoring Architecture Distribution	Corrected SI-AM definition
		Corrected term format
	Monitoring Infrastructure	Corrected SI-AM definition
		Corrected term format
	Monitoring Perspective	Corrected SI-AM and AM-Generic definitions
		Corrected term format
	Monitoring Subject	No modifications made
	Network Delay	No modifications made
	Optimization	No modifications made
	Performance	Corrected BPM-QA definition
	Process Mining	No modifications made
	Quality of Service Dimension	No modifications made
	Requirements Engineering	No modifications made
	Robustness	No modifications made
	Safety	No modifications made
	Satisfaction	No modifications made
	Scalability	No modifications made
	Self-Adaptation	Corrected AM-Generic definition
	Self-Optimization	Moved AM-Generic definition to SI-AM
	Service Based Application Construction	Corrected SC-Generic and ED-Generic definitions
	Service Binding	No modifications made

	Service Description	Corrected term format
	Service Governance	No modifications made
	Soft Goal	No modifications made
	Software Life Cycle Model	Corrected AM-Generic definition Corrected reference to van Vliet 2008
	Task Modeling	No modifications made
	Testing	Correction of TUW competency
	Trust-Worthiness	No modifications made
	Variable Cost	Corrected QA-Generic definition
LERO	Adaptation Requirements and Objectives	No modifications
	Activity	No modifications
	Autonomy	No modifications
	Architectural Knowledge	No modifications
	Architectural Knowledge Management	No modifications
	Business Process Pattern	Removed Generic-Generic definition
	Completeness	No modifications
	Culture	No modifications
	Dynamic Binding	No modifications
	Dynamic Invocation	No modifications
	Data Encryption	No modifications
	Data Policy	No modifications
	Formal Specification	No modifications
	Grid	No modifications
	Monitor	No modifications
	Migration	Added Generic-Generic definition Added competency: Lero Software Process
	Plan	No modifications
	Planning	No modifications
	Stakeholder	No modifications
	Social Network Analysis	No modifications
	Security	No modifications
	Self-Healing	No modifications
	Service	No modifications
	Software Service	No modifications
	Service aspect	No modifications
	Throughput	No modifications
	Traceability	No modifications
	Transactional Service Model	No modifications
	Verification	No modifications
	Validation	No modifications
	Virtual Software Team	No modifications
	Value Network	No modifications
	Web Service	No modifications
	Workflow	Added Generic-Generic definition References added: Hollingsworth 1995, ISO 12052 Added competency: Lero Software Process
POLIMI	Accessibility	No modifications
	Adaptable Service-based Application	New definitions for all ‘non-generic’ cells
	Adaptation Requirements & Objectives	For each domain layer a description added with respect to the KM-QA Moved a sub-definition in KM-ED to Generic
	Analytical Quality Assurance	No modifications
	Auditability	No modifications
	Authentication	No modifications
	Authorization	No modifications
	Capability Maturity Model Integration	Move the current description to the KM-ED/KM-BPM
	Common Features	Moved the initial definition to Generic-BPM and spread the composing sub-definition in the cells
	Cost	No modifications
	Data Integrity	No modifications
	Data Timeliness	No modifications

	Data-Aware QoS	Definitions for SC-QA, SC-ED and BPM-QA added
	Design For Monitoring	Definitions for BPM-QA, BPM-ED, SC-QA and SI-QA added
	Design For Reuse	Definitions for BPM-ED, SC-ED, SC-QA and SI-QA added
	Diagnosis	Definitions for BPM-ED, SC-ED, SC-QA and BPMQA added
	Effectiveness	Definitions for BPM-ED, BPM-QA, SC-QA and SIQA added
	Failure Semantics	Definitions for BPM-ED, SC-ED, SC-AM, BPM-QA, SC-QA and SI-QA added
	Fault	Definitions for BPM-ED, BPM-QA, SC-QA, SC-ED, SC-AM and SI-QA added
	Fixed Cost	Definitions for SC-AM, BPM-QA, SC-QA and SI-QA added
	Globalization	No modifications
	Ideal Model	No modifications
	Information Source	No modifications
	Invasiveness Of The Monitoring Architecture	No modifications
	Key Process Area	No modifications
	Model-Driven Service Composition	Generic (domain independent) modified
	Monitored Event	Generic (domain independent) modified SI-Generic definition added
	Monitoring	QA-BPM definition added KM-QA definition added
	Monitoring in Grid	SI-AM definition added
	Monitoring Usage	SC-AM definition added SC-QA definition added
	On-the-Fly Service Composition	SC-ED definition added SC-AM definition added
	On-the-Fly Service Composition	BPM-ED definition added
	Post-Mortem Adaptation	SC-AM definition added
	Proactive Adaptation	The following has been added: The monitoring technique can be used to implement it (see, for example, Hielscher2008)
	Quality of Service Constraint	Modified existing definition
	Quality of Service Negotiation	Modified existing definition
	Quality of Use Context	Fixed existing definition
	Service Fault	Previous definition is moved from ED to QA
	Service Level Agreement	Preexisting definition in ED has been moved into QA
	Service Runtime Management Process	The old definition is moved from ED to AM
	Stakeholder	A new generic definition is provided
	Software Process Model	A new definition is provided substituting the previous one
	Software Process Capability	Previous definition is moved from ED to QA
	Stateful Service	Existing definition slightly modified
	Throughput	A new generic definition is added
	Transaction Time	Existing definition slightly modified
	User Error	Previous definition is moved from ED to QA
SZTAKI	Business Process Execution	To be refined
	Business Process Pattern	Definitions are modified and added for KM-ED
	Dynamic Binding	Definitions added
	Dynamic Invocation	Definitions added
	Grid Brokering	Definitions added to KM-AM and KM-QA, another reference is added
	Quality Of Service-aware Service Composition	Definitions modified, added to KM-ED, KM-AM
	Self-optimization	Definitions added to KM-AM
	Service Composition	Not modified (coincides with the layer definition)
	Service Coordination	Not modified (coincides with the layer definition)
	Transactional Composite Service	To be refined
	Workflow	Added SI-Generic definition Reference to the ‘The Grid Workflow Forum’ added
TUW	Activity	Added Generic-Generic, SC-Generic and SC-AM definitions Added link to *Business Activity* Reference added: PO-JRA-2.3.2 Requirements for Self Healing Services
	Agile Service Network	Not modified
	Autonomy	Added Generic-Generic definition

	Business Activity	Added Generic-Generic definition Added SC-Generic definition
	Business Process Modeling	Not modified
	Business Process Reusability	Not modified
	Business Protocol	Not modified
	Business Rules	Not modified
	Composition Schema	Not modified
	Grid	Corrected SI-Generic definition Added Generic-Generic definition Reference added: Foster et al, 1998
	Grid Scheduling	Corrected SI-Generic definition
	Interconnected Interface Choreography Model	Not modified
	Replaceability	Added ED-Generic, AM-Generic, BPM-Generic and SI-Generic definitions
	Self-healing	Corrected ED-Generic definition Added Generic-Generic definition References added: M. Salehie et al, 2009, Ghosh et al, 2007
	Semantic Web Services Composition	Added Generic-Generic definition Reference added: Medjahed 2005
	Service Based Application Construction	Not modified
	Service Choreography	Added Generic-Generic definition Reference added: Barros 2005
	Service Mediation	Added SI-Generic definition Reference added: Mrissa 2007
	Service Orchestration	Added Generic-Generic definition Reference added: Barros 2005
	Service Registration	Added SI-Generic defintion Reference added: Dustdar, S., Treiber M. (2005).
	Service Runtime	Added SI-AM definition
UCBL	Adaptation Strategy	Definition for AM-Generic changed Competency added: UCBL Service Engineering Reference added: CD-IA-1.1.1 Comprehensive Overview of the State of the Art on Service-Based Systems
	Completeness	Removed generic-generic definition
	Data Policy	Added Generic-Generic definition Inserted link to *Data-Related Quality* Added reference: Benbernou 2007
	Data Reliability	No modifications made
	Efficiency of Use	No modifications made
	Enterprise Application Integration	No modifications made
	Goal	Added AM-BPM definition Reference added: PO-JRA 2.1.3 Baseline of Adaptation & Monitoring Principles, Techniques & Methodologies across Functional SBA Layers
	Learnability	No modifications made
	Monitoring Requirements	Added AM-BPM definition References added: CD-JRA-2.1.2 Initial Models & Mechanisms for quantitative analysis of correlations between KPIs, SLAs and underlying business processes, CD-JRA-2.1.3 Design of a transaction language
	Postmortem Adaptation	Added SC-AM definition
	Quality Attribute	No modifications made
	Reputation	Added QA-Generic definition Competency added: UCBL Privacy Aware Web-Services
	Self-Protection	Added BPM-AM definition Competency added: UCBL Privacy
	Service Level Agreement Negotiation	Added BPM-AM definition Reference added: PO-JRA-1.2.3 Baseline of Adaptation & Monitoring Principles, Techniques, & Methodologies across Functional SBA Layers
	Service-Oriented Requirements Engineering	No modifications made

	Service Provider	Amended typo in ED-Generic definition Added BPM-QA definition References added: PO-JRA-1.2.3 Baseline of Adaptation & Monitoring Principles, Techniques, & Methodologies across Functional SBA Layers, Liu 2008, Zeng 2004
	Social Network Analysis	No modifications made
	Software Process	No modifications made
	Stability	No modifications made
	User Experience	Added SC-AM definition References added: PO-JRA-1.1.3 Codified Human-Computer Interaction (HCI) Knowledge and Context Factors, BPHBB 07
	User Modeling	No modifications made
UoC	Adaptability	Definition added to SI-Generic cell
	Business Protocol Projection	No modifications made
	Compatibility	Definition added to SC-Generic cell Reference added: Benatallah et al 2006
	Grid Workflow	Corrected typos in original definition
	Service Interaction Pattern	Reference added: Barros et al 2005
	Time-soundness	References added: Mancioppi et al 2008, Mancioppi 2008
UPM	Automated Service Composition	Definitions added for SC-ED, SC-AM and SC-QA
	Autonomy	Definitions added for SC-AM, SC-QA, SI-AM and SI-QA
	BPM Software Suite	Definitions added for BPM-ED, BPM-AM and BPM-QA
	Key Performance Indicator	Definitions added for BPM-ED, BPM-AM and BPM-QA
	Value Chain	Definitions added for BPM-ED, BPM-AM and BPM-QA
	Formal Specification	Definitions added for BPM-ED, BPM-AM, BPM-QA, SC-ED, SC-AM, SC-QA, SI-AM, SI-QA Corrected UPM competency information Corrected Generic-Generic definition
	Safe QoS Bound	Definitions added for SC-QA, SI-QA Updated UPM competency information
	Static Analysis	Definitions added for SC-AM and SC-QA Corrected SC-ED, ED-Generic, AM-Generic definitions Updated UPM competency information
USTUTT	Business Policies	Amended definition BPM-Generic definition
	Business Rules	New definition added
	Business Process Analysis, Monitoring & Auditing	Not modified
	Business Process Measurement	Definition shortened
	Business Transaction	Postponed until the Business Transaction deliverable CD-JRA-2.1.3 provides a definition
	Process	Corrections made to original BPM-Generic definition
	Process Model	No modifications made
	Process Instance	No modifications made
	Process Fragment	Additional SC-Generic definition added
	Self-*	Corrected original SI-Generic definition
	Semantic Web Services	No modifications
	Semantic Web	New term with BPM-Generic definition
	Transactional Service Pattern	SC-Generic definition amended
UniHH	Cost Model	New definition added to BPM-QA References added: Solingen & Berghout 1999, Boehm et al. 2000
	Monitoring Aspect	New definition added to BPM-QA References added PO-JRA-2.1.1 Survey on Business Process Management
	Process Model	Spelling changed from *Process model* to *Process Model* New definition added to BPM-ED Competency added for UniHH: Business Process Management References added: Weske 2007, PO-JRA-2.1.1 Survey on

	Business Process Management
Requirements Analysis	New definition added to BPM-ED References added: PO-JRA-2.1.1 Survey on Business Process Management, Weske 2007
Monitoring In Service Compositions	Merged with *Monitoring* and deleted - We also recommend to apply this change for the term *Monitoring in Grid* which is, however, not under our responsibility
Proactive Adaptation	Added definition to SI-Generic cell Link to more general concept (*Adaptation*) added Competency added: UniHH: Self-Organizing systems References added: CD-JRA-2.3.1 Use Case Description & State-of-the-Art
Reactive Adaptation	Definition added to SI-Generic cell Link to more general concept (*Adaptation*) added Competency added: UniHH: Self-Organizing systems Reference added: CD-JRA-2.3.1 Use Case Description & State-of-the-Art
Data Encryption	New definition added to generic/generic cell Reference added: Salomon 2003
Guaranteed Messaging Requirement	Link to more general concept (*Network- and Infrastructure-Related Quality*) corrected
Service Process Model	Previous definition changed to new definition with grammar corrected Generalization added through link to *Process Model*
Content Accessibility	Not modified
Continuous Availability	Not modified
Customization	Not modified
Monitoring Information Gathering	Not modified
Monitoring Mechanisms	Not modified
Monitoring Timeliness	Not modified
Non-Repudiation	Not modified
Service Oriented Software Engineering	Not modified
Self-Healing	Not modified
Static Analysis	Not modified
Stereotype	Not modified
Usability	Not modified
Ontological Quality Of Service Models	Not evaluated
Adaptation	New definition added to SI-Generic Competency added: UniHH Self-Organizing Systems Reference added: CD-JRA-2.3.1 Use Case Description & State-of-the-Art
Migration	New definition added to SC-Generic Specialization added through link to Runtime Process Migration Competency added: UniHH Business Process Management Reference added: CD-JRA-2.2.3 Algorithms & Techniques for Splitting & Merging Service Compositions
Monitoring	New Definition added to BPM-AM References added: PO-JRA-2.1.1 State-of-the-Art Survey on Business Process Modeling & Management, Leymann & Roller 2000
Process	Specialization added through links to *Process Model* and *Process Instance*
Process Instance	Definition required because term appears in the definition of the term *Process Model* Definition added to KM-BPM/generic Competency added: UniHH: Business Process Management References added: Weske 2007, PO-JRA-2.1.1 Survey on Business Process Management, CD-JRA-2.2.3 Algorithms & Techniques for Splitting & Merging Service Compositions
Context-Awareness	Definition required because term appears in the scenarios and IRF research questions

	Definition added to SC-Generic cell Competency added: UniHH Context Management & Mobile Computing Scenario added: WINERY-S-1 Collaborative Transport Chain Control References added: Dey & Abowd 2000, PO-IA-3.2.1 Initial Definition of Validation Scenarios
Runtime Process Migration	Definition required because term appears in the deliverable and IRF research results Definition added to SC-Generic cell Competency added: UniHH Business Process Management Scenario added: WINERY-S-1 Collaborative Transport Chain Control References added: Zaplata et al. 2009, CD-JRA-2.2.3 Algorithms & Techniques for Splitting & Merging Service Compositions

Table C.1: Results of the QA Process

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